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SANITARY COMMISSION.

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ON

HEMORRHAGE FROM WOUNDS,

AND THE BEST MEANS OF ARRESTING IT.

BY

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THE attention of the Sanitary Commission has been directed to the fact, that most of our Army Surgeons, now in the field, are unavoidably deprived of many facilities they have heretofore enjoyed for the consultation of standard medical authorities. It is obviously impossible to place within their reach anything that can be termed a medical library. The only remedy seems to be the preparation and distribution, among the medical staff, of a series of brief essays or hand-books, embodying, in a condensed form, the conclusions of the highest medical authorities in regard to those medical and surgical questions which are likely to present themselves to surgeons in the field, on the largest scale, and which are, therefore, of chief practical importance.

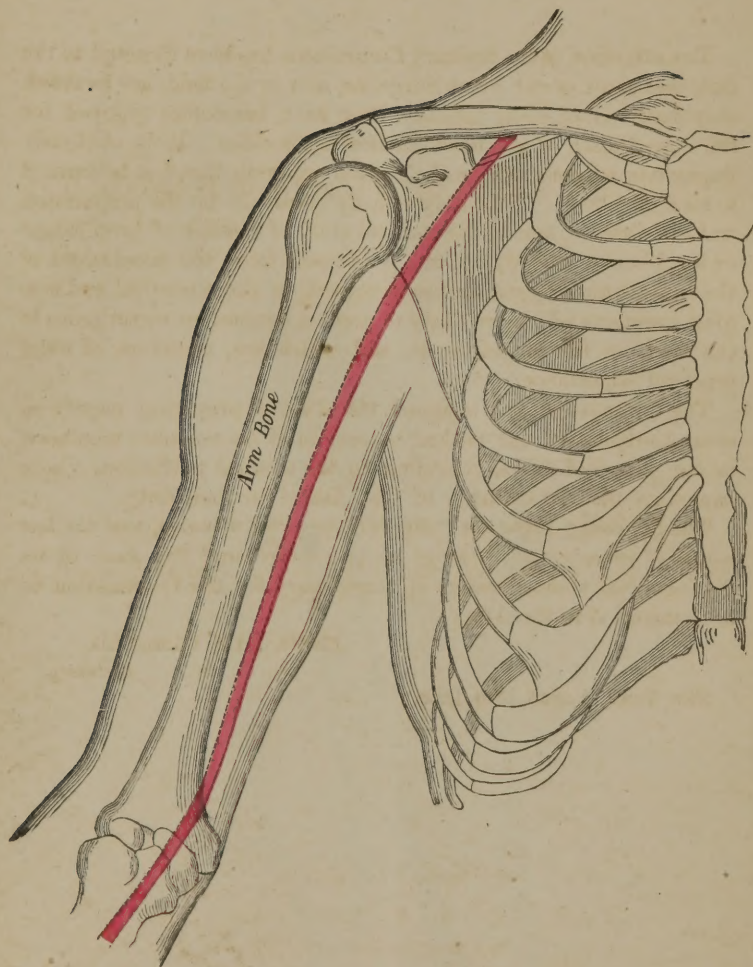
The Commission has assigned the duty of preparing papers on several subjects of this nature, to certain of its associate members, in our principal cities, belonging to the medical profession, whose names are the best evidence of their fitness for their duty.

The following paper on "*Hemorrhage from Wounds, and the best means of arresting it,*" belongs to this series, and the name of its distinguished author renders it unnecessary for the Commission to recommend it to the Army.

FRED. LAW OLMSTED,  
*Secretary.*

NEW YORK, August 15th, 1863.

DIAGRAM 1.

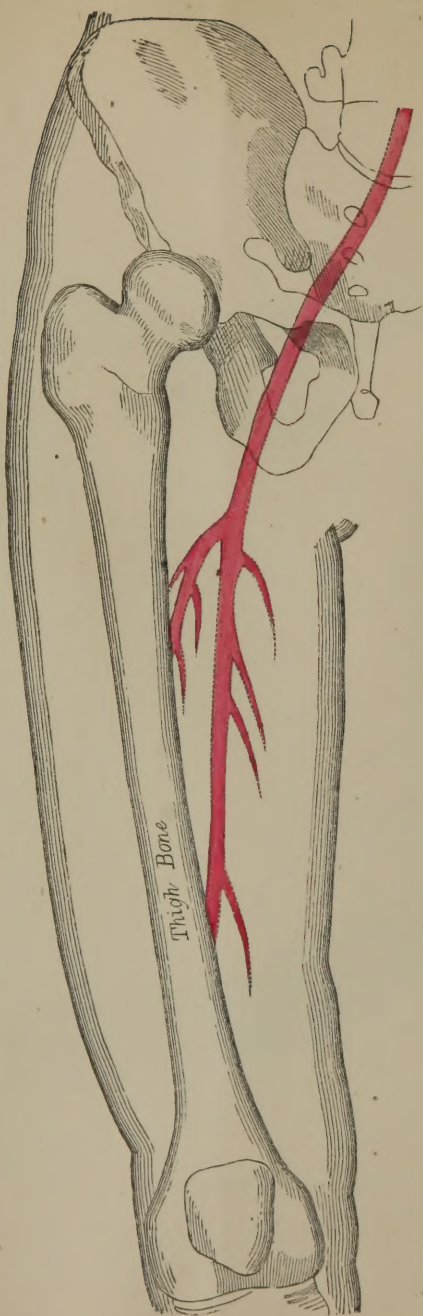


Shews the situation and course of the Axillary and Brachial Arteries.





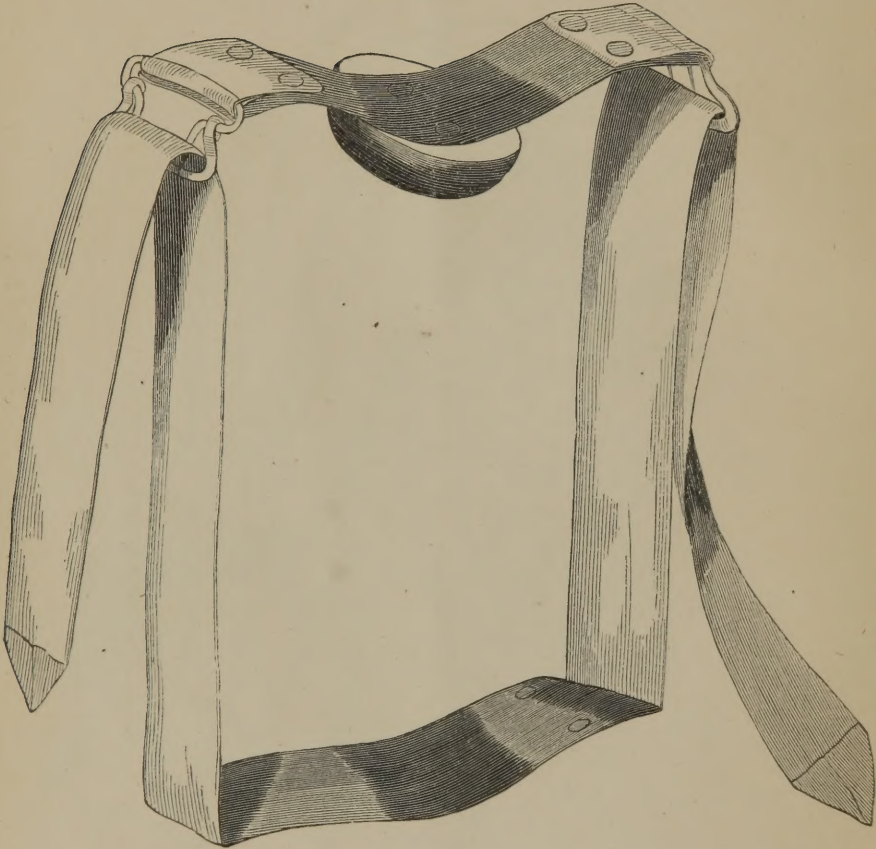
DIAGRAM 2.



The situation of the Femoral Artery at the groin, and its course down the thigh to the ham.



DIAGRAM 3.

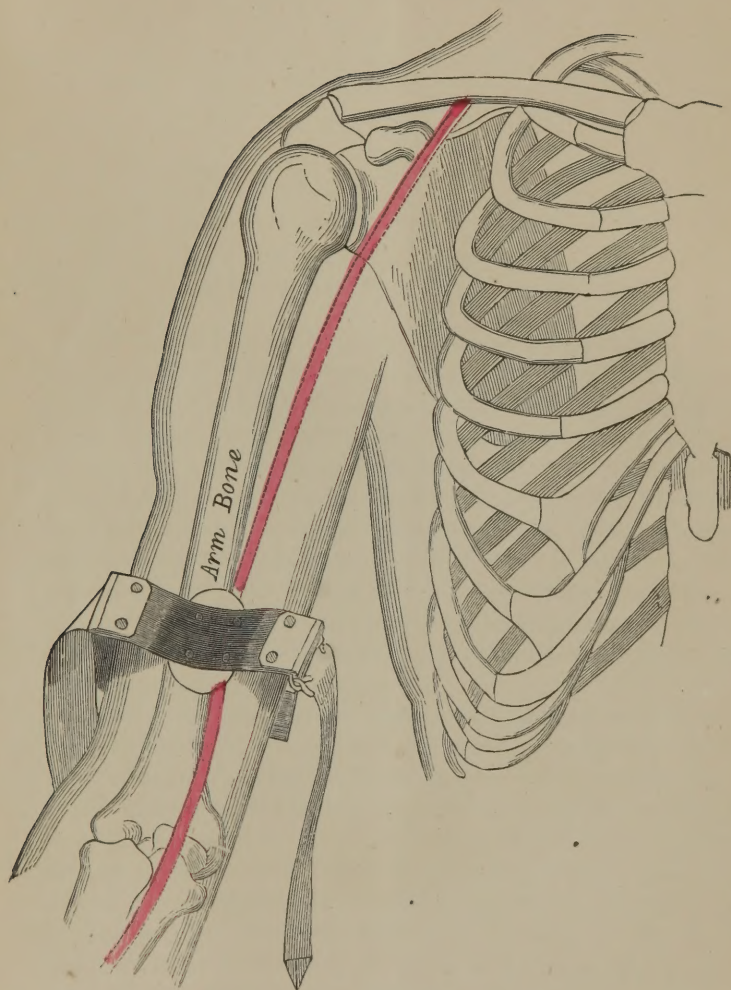


A delineation of the Tourniquet.





DIAGRAM 4.



Application of the Tourniquet to the Brachial Artery.



# ON HEMORRHAGE FROM WOUNDS,

AND THE BEST MEANS OF ARRESTING IT.

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Ter sese attollens cubitoque annixa levavit,  
Ter revoluta toro est oculisque errantibus alto  
Quasivit Coelem lucem ingemuitque reperta.

Thrice Dido tried to raise her drooping head,  
And fainting thrice fell groveling on the bed.—DRYDEN.

THIS beautiful description of the death of the Tyrean queen by hemorrhage is as true to nature, to-day, as it was two thousand years ago. The successive periods of syncope and of recovery, are so admirably depicted that we almost wonder why the ancients, though they knew nothing of the circulation of the blood, did not proceed a single step, and discover that the paroxysms of fainting were immediately due to the "*sese attollens*," the erect posture, and the consequent deficient supply of blood to the brain. And yet, simple and true as this law of nature ever has been and still is, I fear that thousands of poor soldiers in our armies are annually losing their lives from its violation, through the mistaken kindness of their friends.

When a wounded soldier faints, his companions are too apt to leave the ranks and place him in the sitting position, sprinkle him with water, and endeavor by all the means in their power to excite him to consciousness. In this way syncope that might be only temporary, is many times rendered permanent and fatal; for the formation of a clot in the wound, which is the man's only hope of stopping the flow of blood, is thus prevented, and the hemorrhage increased through acceleration of the circulation. If he were allowed to remain in the recumbent position, the coagulum which nature provides would prove an obstacle to the further loss of blood. Were a little useful knowledge of this

kind more generally diffused, what a multitude of lives in the aggregate might be saved!

It is true, notwithstanding all that has been done by the very admirable surgical and sanitary departments of our immense army, that many soldiers still perish on the field of battle from hemorrhage, or are so much reduced as to preclude their subsequent recovery. Humanity and patriotism are deploring, with more than ordinary sorrow, this waste of precious human life, and I have thought, that if some means were taken to disseminate among the officers and men a little rudimentary knowledge of where to apply constriction to the limbs for arresting hemorrhage from wounds, and perhaps to provide them with some simple and cheap means of doing this, no injury could result to any person, and this great cause of mortality might be to some extent diminished.

Of the various forms of death, that by hemorrhage is to our natural instincts one of the most appalling. The associations are all of them revolting—suggestive of the shambles. The glaze of the eye, the ashen hue of the countenance, the cold dewy perspiration, and, withal, the nauseous odor of gore, are sufficient to carry an instinctive shudder to the stoutest heart. To these is added the pain of the wound, and as long as that wound remains open and ready to bleed, though reaction may come on and restore the sufferer to consciousness and life, it is only to experience again the same horrors—the agonies of successive deaths, until Nature fails, and the imprisoned spirit takes its final flight.

My heart sinks, to think how many of our noble Volunteers have passed through these portals in the dark and chilly night after the battle, with no friend near to aid or even pity them, yet fearlessly and bravely have passed through into the regions of immortality beyond!

The means of arresting hemorrhage, before the introduction of the practice of tying arteries by the celebrated Parè in the fore part of the sixteenth century, were of the most rude and cruel kind, such as the actual cautery with red-hot iron, and the application of boiling pitch to the bleeding surface. It is certain that this great and good man could have had no idea of the circulation

of the blood ; how it goes out from the heart to the extremities in throbbing arteries, which hold their course deep within the flesh along the bones, and how, to complete the circuit, it returns in the more superficial blue and pulseless veins ; for all this was discovered by Harvey at a later period. But without this knowledge Parè, inspired with the progressive spirit of true genius, ventured to apply a ligature to the point from which the spiriting jet issued, and the success of his method proved perfect. By it he secured all the advantages of the old practice with hæmostatics, without their cruelty, uncertainty and incompetency. He made a great advance in surgical art, and, so great did his fame become, that his presence was sufficient to inspire desponding armies. At one time, when the garrison of a beleagured city were about to surrender, it became known to them that this great surgeon was among them, and the fact encouraged the soldiers to such continued resistance as in the event proved successful ;—so much did these soldiers fear death from hemorrhage, and so great was their confidence in the power of this man to staunch the flow of blood. Of a like nature is the influence of every surgeon on the men placed in his care, and in this way is the surgeon one of the most important of officers in sustaining the *morale* of a force.

It is a mistake to assume that there is little or no danger of hemorrhage from gun-shot wounds. Wounds of the large arteries of the legs and arms from balls and fragments of shells, punctured or incised, always bleed more or less at the time of reception, and more freely as the shock to the nervous system passes off and reaction comes on. Even where this nervous shock is not sufficient to produce immediate death, the chances for ultimate recovery most frequently turn on the mere question of loss of blood. Surely, then, any knowledge which it is possible to impart to the officers and men, which will be of service to them in that critical moment, when the wound is received, and no surgeon is present to give them attention, should be freely bestowed.

In the progress of the present war, cases are continually occurring which exemplify too plainly the truth of these remarks. At Antietam two young brothers stood side by side in the ranks of our army, and together bravely fell, the one pierced by a Minnie ball



through the lungs, and the other wounded in the thigh by a fragment of shell. He who was shot through the lungs still survives to reveal the horrors of the ensuing night, and relate the story of the tragic death of his brother, who was wounded in the thigh, by repeated hemorrhages from the femoral artery, which the two together were unable to control. When the survivor recounted to me the experience of that fatal night, and told me how his brother bled and fainted, and rallied, and bled, and fainted and rallied again, his bosom overflowed with grief, and his eyes became suffused with tears. But his bitterest sorrow was because he knew that, with the proper means, he might have arrested the hemorrhage, and thus given his brother a chance for his life.

Such instances as these are not isolated, but are continually occurring. In another case which came to my knowledge, the inside of the arm was torn away by a shell, and the man died during the following night from loss of blood while lying on the field of battle. Even as this paper is being prepared, the second officer of one of our vessels of war has fallen a victim to hemorrhage from the loss of a leg below the knee by a cannon shot, which hemorrhage occurred while removing him from the deck to the cabin of the vessel. Nor does there seem to be anything wonderful in this, when we remember that the whole circuit of the circulation is performed in but a few minutes.

Of the different methods of arresting hemorrhage which have had their place in history, such as the use of hæmostatics, charms and liquids that would decompose the blood, none of them are worthy of notice when compared with the grand principle of stopping the effusion of blood by mechanical constriction of the artery which supplies that fluid—constriction either in the wound itself or at some part between the wound and the heart.

All the anatomical knowledge which is strictly necessary for effecting such compression, may be acquired by both officers and men from the accompanying diagrams, and this knowledge is of such a nature that I think it may be readily understood, and will not be easily forgotten.

We must remember that each limb, be it an arm or leg, is supplied with blood by one main artery, which pulsates like that of the wrist, and whose pulsation may be felt in the

same way that the pulse is felt at the wrist, when we use sufficient force with the fingers to press the artery down upon the bone in any part of its course. In this way it is that the supply of blood to the limbs may be at any time summarily stopped, and, as a consequence, bleeding of wounds of the arms and legs speedily arrested. As there is but one great arterial bloodvessel in the arm above the elbow, and but one of account in the thigh above the knee, it is most convenient to arrest the supply of blood to the limbs by applying the constriction at some point of the thigh or upper arm, even though the wound from which the hemorrhage occurs should be of the foot or hand.

For these reasons also, it is only necessary to call the attention of the officers and men to the relative positions of the artery and the bone in these two regions, that is in the upper arm, and in the thigh, to enable them to understand and put in practice in case of necessity the Tourniquet, one of the greatest inventions of modern times. I would especially advise Captains and Lieutenants of companies to make themselves familiar with the practice of arresting the circulation in these two regions by practicing at their leisure upon themselves and on the men.

The elements of Anatomical Science should be more diffused amongst the people. So little is this kind of knowledge generally known, that a Captain of the army of the Potomac with whom I was lately conversing, expressed surprise when I informed him, that the main artery of the lower limb passed down in front along the groin, as he had always supposed it to be somewhere in the back part of the limb. At my request, in the sitting position as he was, he placed the ball of his thumb on the upper part of his groin and bearing firmly down, compressed the artery upon the bone beneath it, until he stopped its pulsations; thus gaining knowledge which may yet be of the greatest service to him, and knowledge of which I would that every soldier of my country, who is liable to die by hemorrhage on the battle-field, might be possessed. It was by possessing such knowledge as this, that an intimate and valued friend of mine, a distinguished British officer, succeeded in saving his own life. He had lost a leg below the knee, from a cannon shot, and was bleeding profusely, but succeeded in

binding his sash so tightly about the stump as to arrest the flow.

By reference to the first diagram it will be seen, that the great artery which supplies the arm with blood, passes out from the chest under the collar bone, and over the first rib. At the crossing of the artery over the first rib, Surgeons, when about to amputate at the shoulder joint, arrest the circulation, by pressing down upon the artery from above and behind the collar bone, at about its centre, with some smooth flat substance which will readily indent the flesh, such as the ring of a door-key. But it is hardly to be supposed that unprofessional persons without experience should succeed at this obscure point; and, as bleeding from wounds in the armpit is the only accident to which this treatment is ever applied, I will rather presume the process to be impracticable to the uninitiated, and direct the wound itself to be immediately filled with some substance, such as a portion of the shirt or other clothing, and constriction applied directly to the source of the flow.

The highest point of the arm then to which we will consider the Tourniquet applicable, is the axilla or armpit, and here it is to be applied with the pad directly over the wound, with or without other filling, and tightened over the top of the shoulder until the hemorrhage is arrested.

By referring to the diagram again, we shall see that the artery, after leaving the arm-pit, passes down along the inner side of the arm, winding forward, until at the bend of the elbow we find it occupying the centre of the front of the arm, directly under the veins where the operation of blood-letting is usually performed, which is the lowest limit of the region for the application of the Tourniquet in the superior extremity. Here the pulsation of the artery may be readily felt in the human body by pressing upon it with the points of the fingers.

If we divest the superior extremity of clothing, and lay a piece of twine with one end over the middle of the collar bone, and the other over the centre of the space in front of the elbow, this line will mark out the position of the brachial artery; and in thin persons pulsation may be felt along its whole course. The pad of the Tourniquet may be applied to any portion of this line and

when sufficient pressure is made, the artery will be forced down upon the bone, and the circulation controlled, which will be indicated by the suppression of the pulse at the wrist.

It is better to apply the Tourniquet above the elbow, even in wounds of the hand or forearm, as the artery divides at the elbow and its branches are also more protected from the proper pressure of the instrument by the presence of two bones. But if the hemorrhage still continue after the application of the Tourniquet to the upper part of the arm, I would fill the wound and apply pressure immediately to the bleeding surface.

The second diagram is intended to show the course of the great artery of the thigh from the centre of the groin, where it leaves the cavity of the abdomen, down to the centre of the hollow space behind the knee. The pulsation of this artery in the groin may be distinctly felt with the fingers or ball of the thumb, when the thigh is bent towards the body, by pressing in the groin about half-way between the point of the hip-bone and the centre of the body. The pressure must be sufficient to reach the bone beneath, and varied a little along the course of the bone, until the artery is detected. This is the highest position in the inferior extremity to which the Tourniquet can be applied in wounds of the groin, and in such cases it is generally necessary, from the profuse hemorrhage, also to stuff the wound. I would do all that was possible by either or both methods to stop the loss of blood. Where the wound is very high, the band of the Tourniquet may be allowed to pass around the hips, placing the pad over the stuffing of the wound. No harm can come from the trial, though it is very difficult to control the artery by any instrumental means at this point.

The lowest point of the inferior extremity to which it is customary to apply the Tourniquet, is the popliteal space behind the knee. If the leg be bent nearly to the thigh, and the ends of the fingers pressed between the two lines of the cords, in the space behind the knee, so as to bear upon the bone, the pulsation of the artery will be distinctly felt at this point, and by sufficient force may be arrested. In fact, this is one of the most convenient places for applying the Tourniquet when we are allowed our choice, as the broad extremity of the thigh-bone forms an admirable



support, and the hollow space secures a fixed position of the pad.

Having discovered the artery then, at these two points, namely, near the centre of the groin above, and in the centre of the space behind the knee below, it only remains to join the two by a line which will pass from the pubic bone down along the inside of the thigh bone, gradually winding backward until it is directly behind at the knee. The pulsations of the artery may be easily detected through this entire route in thin persons, but its path is not so readily discovered as that of the main artery of the arm.

To any portion of this region the Tourniquet may be applied with the pad over the artery, and sufficient pressure will arrest the current of the circulation, and prevent bleeding from a wound below. If the location of the wound should be such as to allow us a choice of places, it is customary to prefer a point about one-third of the way from the knee, as the artery is here more close to the bone.

To wounds penetrating the three great cavities of the body, that is of the chest, head and abdomen, the Tourniquet is not applicable. Such wounds should be left open for the escape of blood, as the accumulation of clots in either of these cavities soon leads to fatal results. Hence all the anatomical knowledge that is requisite for the successful use of the Tourniquet, is in fact conveyed in what has been said of the regions of the upper arm and thigh.

Having this knowledge, any person on the field of battle may pick up a stone of the size of a hen's egg, and place it over the main artery of the arm, secure it by tying with a handkerchief or sash, and exert pressure by passing a bit of stick through over the stone, and taking a turn or two until the pulsation at the wrist ceases, or the bleeding is controlled. And the same may be effected in the inferior extremity by the same means, using of course if convenient a stone somewhat larger for the pad, and feeling just back of the inner ankle for the pulse to determine when the circulation is controlled.

In the most primitive form of Tourniquet the band made two turns around the limb, and was knotted over the artery. The stone was placed under the inner turn of the band, while the



stick was passed through under the outer turn only, that is, under the knot and over the stone. The arrangement was then tightened by twisting with the stick. In another form the stone was enclosed in the center of a shawl or large handkerchief, which was folded diagonally and passed twice around the limb, and the free corners then knotted over the stone. Torsion was then made with a stick.

In the early part of the last century, Pètit, a French surgeon, improved these simple devices by adding a screw, with which to force the pad down upon the artery, thus giving to the instrument the form in which it is now most frequently used. In his Tourniquet, the apparatus for tightening the band consists of two plates, which are placed over the artery, and separated by means of a screw.

Since the time of Pètit, there have been suggested various modifications in the form of the instrument, such as making the band of a hoop of iron or brass, to relieve from pressure the sides of the limb; giving the threads of the screw a steep inclination, to secure rapidity of action; or making the threads of the screw to wind in opposite directions on different portions of the same spindle, to attain the same result: but, in the main features, all these instruments are essentially the same.

But, however desirable the screw and plates may be as an apparatus for tightening the band, they are not always to be obtained. Their weight and bulk, and complicated nature, operate to prevent their presence on the field of battle, and thus to limit their use to the practice of medical men.

And the objection to the French Tourniquet is, that its application requires the assistance of a second person, while, for military and naval purposes, the instrument which can be applied by the wounded man himself must ever have the preference.

To meet these special requirements, a number of instruments have been contrived in different countries. That of Dr. Lambert, of this country, is very good; but the one invented by my son, Dr. Alexander B. Mott, is more simple in construction, more neat, and compact, and portable, and is the one we prefer. It is eminently fitted for military and naval practice, and well adapted to the walks of private life.

One great excellence of this instrument is, that it can be applied by the wounded man himself. Its cheapness is another of its good qualities, as the cost will not exceed fifty cents; thus placing it within the reach of every private soldier as well as every officer in the army, who may desire its protection.

Diagrams Nos. 3 and 4 represent this instrument and illustrate its modes of application.\*

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\* The following letter from my son gives a full account of the construction of this instrument and its application:—

209 TENTH STREET, NEW YORK, May 24th, 1863.

DEAR FATHER:—Believing that the tourniquet which I send you, has numerous advantages over all other instruments of the kind now in use, I beg you will give it a trial, and if it meet your approval it will afford me pleasure to see it adopted by you, and recommended to the profession.

As you will notice, its construction is very simple, and its application not complicated—it can easily be repaired by any ordinary mechanic.

Another good quality which it possesses is, that it may be cleansed with water, without fear of rust or injury to any of its component parts. It is composed of steel plates, the anterior one  $5\frac{1}{2}$  inches long, having a wooden pad (grooved or smooth) permanently attached; transversely to its centre by two (2) screws; the ends of the plates thrown up from the centre so as to form wings, and having attached to either end ordinary buckles secured by copper rivets through a piece of webbing.

The posterior plate  $5\frac{1}{2}$  to 5 inches long is of the same material and somewhat of the same shape, having but one point of pressure, the centre; at each extremity is riveted a piece of webbing 12 inches long.

The mode of application I believe would present itself to the mind of any casual observer, and therefore needs but little explanation.

Either strap is to be passed around the limb (arm or leg) and through the buckles, thus securing it, care being taken to place the posterior plate on the opposite side of the limb to the anterior one; the wooden pad is then to be placed over the artery to be compressed, and either or both straps drawn sufficiently tight to obstruct the current of blood through the vessel.

Having furnished a sample of this Tourniquet about two months since to Brigadier General W. A. Hammond, Surgeon General U. S. Army, I am happy to say that it met with his approval, and I trust will find its way into the army, as I believe it fulfils all the requirements of a field Tourniquet, being portable, less complicated than any now in use, and readily applied with one hand by a wounded soldier upon himself.

I likewise claim for it the important advantage of arresting hemorrhage in

Before closing this article, perhaps it may be proper to say that some objections have been urged to the general use of the Tourniquet by unprofessional persons. It is alleged that the instrument might be placed on the wrong side of the wound, and in this way do more harm than good. But this objection answers itself, as the most ignorant operator would immediately change the position of the instrument when he found the hemorrhage increased.

Another objection which we more frequently hear is that a swelled or puffy condition of the limb is produced by the constriction of the Tourniquet when long applied, rendering it more difficult for the surgeon to perform the subsequent operations of amputation, or the securing of vessels. But we must remember that in most cases the subsequent operations will eventually be performed above the wound, and so also above the Tourniquet, where swelling and infiltration do not occur. But this objection also answers itself in a practical way, for some sort of constriction will probably be applied, as there are no men who would prefer to bleed to death rather than impose a difficult operation on the surgeon.

A third objection, and one which appears at first sight more plausible than those just mentioned, is, that mortification and the death of the limb would be induced by leaving the Tourniquet too long in position. But, I cannot conceive of any military necessity for keeping the circulation suppressed by the Tourniquet more than an hour or two; and yet I have seen the circulation as completely abrogated as it can be by means of this instrument for a number of hours at a time without unfavorable results. Nor have I, in any case of practice, judicious or injudicious, ever seen any bad

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cases of wounds of arteries, without interrupting the collateral circulation in the limb to which it may be applied; thus allowing reaction to take place, and the removal from the field, of wounded, for many miles before surgical interference is necessary.

This instrument was made under my direction by Messrs. Tieman & Co. of this city.

Your affectionate son,

ALEX. B. MOTT, M. D.,

Prof. of Surgical Anatomy, and Surgeon U. S. Vols.

Prof. VALENTINE MOTT, M. D.,

New York.



effects follow the continued application of the Tourniquet, that could be fairly and truly attributed to that instrument. It is true that many of the severely wounded, after some days, will die of typhoid symptoms, which are attributed to phlebitis and pyemia but I choose rather to perceive the primary cause of death in such cases, to be very generally an excessive loss of blood at the time of receiving the wound, or the repeated occurrence of secondary hemorrhage.

But if all these objections were cogent and true, they amount to nothing when brought into conflict with that great law of the medical profession, which directs and determines all our art, namely, to prolong life for any time, however short, by any means, however expensive. "*Sire*," said the great Baron Larrey, with unswerving integrity, to the first Napoleon on a memorable occasion, at the siege of Jaffa, "*It is my avocation to prolong human life, and not to destroy it.*" So, in any case of serious hemorrhage, contingencies, remote and uncertain, are not to be taken into the account, but the urgent necessities of the moment are to be met at once, by measures the most convenient and effective. Even in those cases where ultimate death is inevitable, it is better to prolong life for a time than to see the patient helplessly perish in our hands; and I believe that, in any case of hemorrhage, it is better to suffer the temporary evils of the Tourniquet, than to permit any serious loss of blood, and consequent shock to the nervous system.

Many of the low forms of fever that prevail in hospitals have their origin in the debility which has been produced by hemorrhage from wounds. The immediate effects of loss of blood upon the nervous system are very apparent, in that suspension of the faculties of the mind which is known as fainting, and from which the persons, in most cases, soon recover. But where hemorrhage is excessive in the first instance, or frequently recurs, a permanent affection of the nervous system is induced, indicated by a fluttering pulse, pain in the head, flushed face, ringing in the ears, irritability of the stomach, and other symptoms of typhoid fever.

It is to the nervous system that we must look for any explanation of the intermitting and remitting character of fevers, or even those slight remissions that attend fevers in their most continued

forms. For the nervous system is the only system in which regular remissions constantly recur. I believe that the lesions that are now discovered after death from fevers, are rather the effects than the cause of the disease; and that if we shall ever become able to inspect the nervous system in the same clear and conclusive way that we now examine other organs of the body, in post-mortem cases, this doctrine will be conclusively established. In diseases of the brain, depletion affects the nervous system more promptly than any other agent; and, in the same way, excessive loss of blood produces those low forms of typhoid disease which have their origin and seat in the nervous system. Let the Tourniquet then be applied to prevent the subsequent occurrence of pyemia and typhoid fever.

There is another advantage which would be gained by the general introduction of the Tourniquet among the troops, which is too important to pass unnoticed. It is the moral courage and confidence which the possession of this instrument would give the soldiers. We have seen that in some cases men dread the manner of death more than death itself, and that, in general, death by hemorrhage is regarded with most horror. We have seen that it was by possessing the power to control hemorrhage, that Paré infused a brave spirit into the French troops. So the possession of a Tourniquet by any soldier who feels competent to use it, supports his courage, and he feels that if wounded in the service of his country, his blood will not be needlessly wasted. In this way, slight material causes frequently give rise to extensive moral and political results, and I hope this simple instrument, which I recommend, may not only save the lives of many individual soldiers, but, by increasing the confidence of the troops, in some measure may contribute to the final success of our arms; and it is with these views that I have devoted the necessary time and labor to the production of this monograph, though at a period of life when men naturally incline toward repose.

But in this great struggle whatever is left of my days is at the disposal of my country, whether it be with the sword, or with the knife, or with the pen—on the field of battle, in the hospital, or at home.

The lapse of years is beginning to admonish me, that what



more I have to say or do for my fellow men must be said or done quickly. And if the exigencies of this conflict should require it, I am ready not only to sustain our army with words of fortitude and hope, but again to don the harness, and make one more campaign of active service in the cause of my country, and devote to her whatever remains of the autumn of my life with its autumnal fruits.